

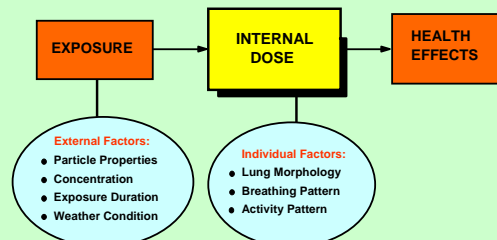
What Do Exposure and Dosimetry Studies Tell Us about the Respiratory Dose to Susceptible Populations?

Chong S. Kim¹ and Ronald Williams²
U.S. EPA, Office of Research and Development

¹National Health and Environmental Effects Research Laboratory, Human Studies Division and

²National Exposure Research Laboratory, Human Exposure and Atmospheric Science Division

Exposure and Dose Assessment Are Key Steps for Successful Health Risk Assessment



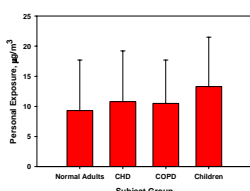
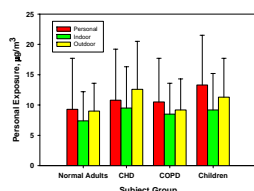
RATIONALE

- Particulate pollutant in the air causes harmful effects to people, particularly the elderly, children and patients with respiratory or heart disease.
- Besides the fundamental underlying factors yet to be identified, internal dose is an important factor for determining health risk of inhaled particles: greater the dose, greater the risk.
- Some people are subject to a greater dose than others because of their personal exposure environment or individual factors such as age, disease and life style.

QUESTIONS

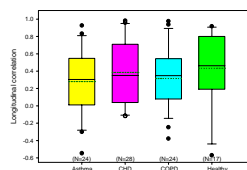
- What are the exposure-dose relationships for susceptible populations compared with those for normal subjects?
- What is the relationship between ambient PM and personal exposure to PM in potentially susceptible subpopulations?
- To what extent does enhanced respiratory dose play a role in determining susceptibility?
- If a higher dose is a crucial factor for susceptibility, are there any other subject groups that are susceptible but not yet identified?

Personal Exposure Levels Are Comparable among Different Subject Groups Including the Elderly and Patients with Respiratory and Heart Disease



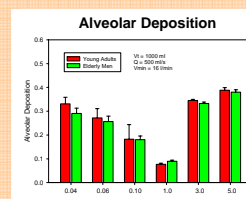
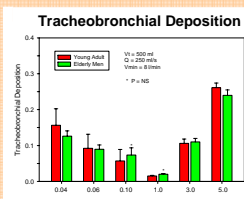
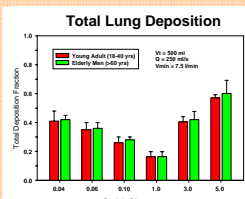
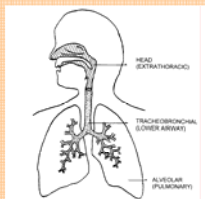
Relationships of personal PM_{2.5} with indoor and outdoor measurements are consistent among four different subject groups.

Personal PM_{2.5} measurements are similar for the healthy and sick cohorts. Some variations seen in the graph are probably the result of time activity pattern differences among the subject groups, especially the children.



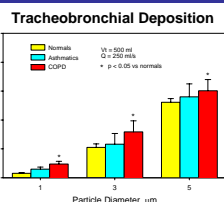
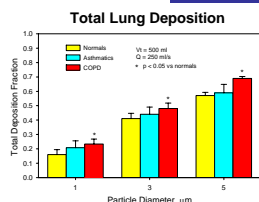
Longitudinal correlation between personal PM_{2.5} and central measurements are comparable among four different subject groups including patients with asthma, coronary heart disease (CHD), and chronic obstructive pulmonary disease (COPD).

Total and Regional Lung Doses of Inhaled Particles Are Comparable between the Elderly and Young Adults under the Same Exposure Conditions.



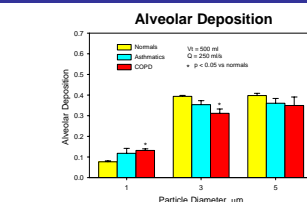
Total as well as regional (tracheobronchial and alveolar) lung deposition is essentially the same for both the elderly and young adults during normal controlled breathing in a wide range of particle sizes (ultrafine, fine and coarse particles).

Lung Deposition Dose Is Enhanced in Patients with Obstructive Airway Disease such as Asthma and COPD



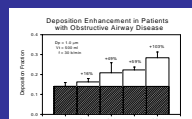
Total lung and tracheobronchial deposition increase in patients with obstructive airway disease such as asthma and COPD.

Deposition enhancement in the Tracheobronchial region is consistent regardless of particle size.



Alveolar deposition increases for fine particles, but tends to decrease for coarse particles in patients with asthma and COPD.

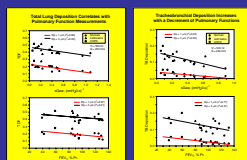
Marked Enhancement of Local Dose is the Hallmark of COPD Lungs and a Potential Risk Factor



Enhanced Local Dose in Patients with Asthma and COPD



Lung Deposition vs. Pulmonary Function



Both total and tracheobronchial deposition correlate well with measures of airways obstruction: an increase in deposition with increasing degree of obstruction.

CONCLUSIONS

- The time activity patterns rather than disease state would appear to be a more important variable for personal exposure to PM of outdoor origin in susceptible populations.
- Personal exposure levels are comparable among different subject groups including the elderly and cardiopulmonary patients. Thus, respiratory dose may be determined primarily by internal factors.
- Because particles are deposited with greater efficiency and in concentrated local "hot spots" in subjects with obstructive airway disease, the internal dose delivered to these populations is higher than for healthy individuals.
- Enhanced local rather than the total lung dose may be a better dose metric for estimating the risk of PM exposure in susceptible populations.

